Municipal Engineer

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ice | proceedings

Proceedings of the Institution of Civil Engineers

http://dx.doi.org/10.1680/jmuen.16.00036
Paper 1600036
Received 24/06/2016 Accepted 27/12/2016
Keywords: infrastructure planning/town & city planning/transport planning

ice Institution of Civil Engineers
publishing

Appraisal of public park accessibility in South African cities

Dillip Kumar Das PhD, MCP, AITP
Senior Lecturer, Department of Civil Engineering, Central University of Technology, Free State (CUT), Bloemfontein, Free State, South Africa (corresponding author: ddas@cut.ac.za)

James Edward Honiball BTech, MTech
Lecturer, Department of Civil Engineering, Central University of Technology, Free State (CUT), Bloemfontein, Free State, South Africa

Underutilisation of public parks in the residential areas of South African cities is a challenge. Although accessibility, environmental and social factors are argued to be some of the challenges for the utilisation of parks, the challenges of accessibility – particularly in the residential areas of cities are least explored. This study examined the most important accessibility factors that influence the use of public parks and how the utilisation of public parks can be improved in the residential areas of South African cities. For this purpose, a case study was performed by using Bloemfontein city of South Africa. Findings suggest that the ratio of road network to pedestrian facilities network, the number of access streets to the parks, size (in area) of parks and the level of illumination in the parks during evening periods are the major variables, which to a varied extent influence the utilisation of parks. An optimal level of number of access streets to the parks, proportionate pedestrian facilities on the roads providing access to parks and appreciable illumination will enable significant improvement in the utilisation of parks in the residential areas of South African cities.

1. Introduction

There is a greater demand for the creation of public parks in cities particularly – in residential areas– due to their contributions to the socioeconomic and environmental health of the cities (Kumar, 2015; Sallis *et al*., 2004). Accordingly, public parks have become one of the core land uses in the city development plan. Although a number of such public parks have been developed in the South African urban areas, it has been observed that except for a few major and organised ones, the others are barely utilised. The underutilisation of these public parks are attributed to many factors that include lack of amenities, inappropriate location, lack of attractiveness, lack of accessibility, behavioural issues such as lack of time and life style, social issues such as crime or fear of crime to name a few. However, according to a Project for Public Spaces (PPS, 2011) model, the success of public parks depends on several major determinants, which include accessibility, image, comfort, sociability of the space and engagement of people in physical and social activities. Physical accessibility – in terms of availability and quality of access facilities (road communication), cost of accessibility, time–distance relationship from the residential areas, parking and security facilities – is considered one of the most important characteristics influencing successful utilisation of these public parks. Similarly, visual accessibility variables such as sight distance, visibility of the parks and illumination level in and around the parks are argued to influence utilisation of public parks. Accessibility of public parks in the city is thus largely affected if the related infrastructure and services are not adequately provided and/or they do not perform efficiently (PPS, 2011). Thus, it is crucial to evaluate the most important determinants, which influence accessibility of public parks in the residential areas of a city particularly in South Africa in order to evolve planning and design guidelines to improve accessibility and utilisation of public parks.

In this context, a case study was performed by using public parks in the residential areas of Bloemfontein city in South Africa. It has been observed that most of the parks in the residential areas of Bloemfontein are underutilised. The user rate ranges between as low as about <100 to about 1000 per month. Therefore, various accessibility factors that are influencing such underutilisation and the relation between the factors and park use were examined and a partial conclusion was reached.

2. Accessibility of public parks: evidence from the literature review

Public parks offer a unique setting within the urban landscape, providing opportunities for physical activity, enjoyment of nature, social interaction, health benefits and break away from routine life (Hayward and Weitzer, 1984; McCormack *et al*., 2010). Planning, design and redesign of public parks and their upkeep are thus vitally important for population health and the society (Hayward and Weitzer, 1984). One of the important aspects for success of parks, which has been emphasised in the literature of public parks is access (PPS, 2011) because lack of accessibility and distance are inversely associated with use, physical activity behaviour and mental health of people (Deshpande *et al*., 2005; Kaczynski *et al*., 2008; Payne *et al*., 2005; Potwarka *et al*., 2008; Sugiyama *et al*.,

2008). According to the PPS model, spatial accessibility is generally premised on the proximity, location and size of the parks, and a successful public park needs to be easily accessed, commuted through and visible (PPS, 2011; Zhang *et al*., 2014). According to some scholars, distance or walking time to parks are important preconditions for access and use of public parks and the parks should not be more than a few minutes' obstruction free walk or short bicycle distance from most residences, public buildings or shops (Atiqul Haq, 2011; Cutt *et al*., 2008; Herzele and Wiedeman, 2003; Lee and Kim, 2015; Neuvonen *et al*., 2007). Access to public transportation was also identified as an enabler for public park access and parks on regularly walked routes are observed to be accessed and used more often than those located elsewhere (Atiqul Haq, 2011; Day, 2008: p. 306; Etzioni, 1998; Ferré *et al*., 2006; McCormack *et al*., 2010). The lack of bicycle lanes and pedestrian sidewalks connected to parking areas near public parks create constraints in the accessibility of public parks (Nevhutanda, 2007). Similarly, pedestrian safety is a major concern with respect to accessibility to public parks. Pedestrian safety is largely reliant on the design elements of the roadway and land use surrounding the roadway. Land use planning should provide facilities and services that ensure continuous and safe pedestrian access, which can increase access to public parks (Nambuusi *et al*., 2010). Similarly, the other relevant aspects to consider regarding accessibility to public parks are the visibility of the space from a distance, interior visibility – illumination, usability, functionality with respect to people with special needs, availability of various modes of movement and availability of convenient transportation nodal points close to park entrances (Lee and Kim, 2015; PPS, 2011).Thus, accessibility forms a vital element for success and higher utilisation of public parks and needs thorough investigation.

3. Case study: Bloemfontein, South Africa

Bloemfontein in South Africa was chosen as the study area for this investigation. Geographically, Bloemfontein is situated at 29°06′S and 26°13′E at an altitude of 1395 m above sea level. It is the capital city of the Free State province and judicial capital of the country. The city has a hierarchical and well-distributed network of public parks. The public parks in the city can be categorised as regional parks at the metro-municipality level, central parks at the city level, and parks and play grounds at the neighbourhood and residential area level. There are about 202 public parks in the city, covering an area of 167 km^2 – implying an average of 1·2 parks for every square kilometre. Every residential area and neighbourhood contains a number of public parks and play grounds. Apparently there is a public park within 1·5 km walking distance from every residential dwelling (IDP, 2011). These public parks and play grounds in the residential areas, which offer free access to people were considered for the purpose of this investigation. All other open spaces such as stadiums, sport arenas, sport facilities, nature reserves, regional parks, zoos and botanical gardens that require people to pay a certain fee in order to gain access, have been kept out of the scope of this study.

Currently, the Mangaung metro-municipality has initiated an 'adopt a park policy' by involving individuals and communities to improve the condition of the parks, make it clean, green and safe as well improve their usability (*Draft Policy: Adopt a Park Policy*, MM, 2015). In spite of the initiatives, as observed from the survey of this investigation, the public parks in the residential areas are not used to their full potential. There are a number of factors that contribute to their underutilisation among which accessibility is a major reason. Thus, it is necessary to assess and analyse the accessibility to these public parks to evolve plausible policy interventions for improving their use.

4. Methodology: survey, data analysis and modelling

A survey research method, followed by statistical analyses and empirical modelling approach, was used in this study. Data from primary field surveys were used in the analyses. Primary field surveys were conducted to obtain first-hand data at the study area level. For this purpose, four out of the 26 suburbs of the city were chosen, namely Batho (eastern part), Universitas (south-western part), Langenhoven park (western part) and Lourier park (southern part). These suburbs were selected on the basis of a set of selection criteria that include location, population, social and demographic condition, type of accessibility through road network, location, size and availability of public parks. These suburbs are densely populated and have a number of public parks, and apparently represent the heterogeneity and diversity of the demographic and public park characteristics of the city. Three kinds of primary surveys – household, physical condition of parks and public park use surveys – were conducted in these selected areas. Household surveys were conducted among 240 households (60–80 households in each suburb) by using a pretested questionnaire (one questionnaire per household). The survey was conducted by the researchers through semi-structured interviews among the respondents. Out of the 240 households surveyed, 208 (86·7%) have responded appropriately. However, after elimination of errors and improper responses, 200 questionnaires with proper information were used for the analysis. Some of the relevant and important questions included in the household survey questionnaire to obtain the perception of the people were: demographic and social attributes of the respondents, park infrastructure, park use, and physical and visual accessibility aspects. Data on the physical condition of public parks in the selected suburbs, their accessibility to users and park use were obtained by conducting physical surveys and

public park use surveys. The information collected from these surveys was also supplemented by the up-to-date geographic information system data obtained from the metro-municipality. The physical condition of parks and park use surveys were conducted by using continuous digital photography and videography. Twenty-four public parks located in the four selected residential areas were identified for the physical and park user survey. Care was taken to select the parks, which apparently represent the characteristics of the majority of the parks in the residential areas of the city. The selection of these public parks was based on their location, size, accessibility, illumination level, availability of facilities and apparatuses, condition and usability. Specifically, parks located in the residential areas that have the potential for significant uses were selected for the survey. Parks that were either too large, too small parks or in defunct condition have been excluded. Cameras were set up at each of the identified public parks, which filmed the parks for 7 d non-stop to monitor the daily use of the parks and various accessibility issues. Physical accessibility was evaluated based on the availability of pedestrian facilities and road network leading to the parks. Pedestrian facilities include properly maintained paved pathways along the roads without obstructions/barriers/encroachments/gaps. The road network includes the local roads and access streets passing through the residential areas. Access streets imply the roads that are directly leading to the parks. While analysing the accessibility factors the ratio of pedestrian facilities length to road network length was considered as a parameter for the convenience of analysis as both are dependent on each other.

The data collected were analysed by using the weighted average index method, correlation coefficients, variance inverse factor (VIF) tests, significance tests and regression analysis.

The weighted average index method was used to determine the people's perception indices (PWI) of the various variables influencing the access and use of public parks. The PWI was developed by using the values assigned by the respondents as obtained from the household surveys. On the basis of their perception and/or direct and indirect experience with regard to the challenges and opportunities of park uses, the respondents were asked to assign a value to each variable on a scale of 0–1 (0 indicates the lowest influence and 1·0 indicates maximum influence), which influences the use of parks. While developing this index, care was taken to exclude irrelevant, subjective and uncertain responses.

The model used for the development of PWI is given in the following equation

$$1. \quad \text{Perception weighted average index} = \text{PWI} = \frac{\sum P_i \times N_i}{\sum N_i}$$

where N_i is the number of respondents and P_i is the index values provided by the respondents on a scale of 0–1 in household surveys.

Empirical regression models were developed and trend analysis and significance tests (F distribution and t-test for p values) were conducted to establish the causation between the important accessibility variables and use of parks and also the implication of these variables on the use of public parks. During analysis of data care was taken to eliminate the insignificant and irrelevant out layers that could distort or introduce bias in the analysis.

5. Results and discussion

5.1 Factors influencing accessibly and consequent uses of public parks

Table 1 presents the relative influence of the factors of accessibility on the use of public parks, based on the perceptions of people. The major factors that influence park uses are walking to public parks (PWI = 0·99), period of the day (afternoons and evenings (5–8pm) (PWI = 0·75)), walking distance (PWI = 0·69), and the level of illumination in the public parks (PWI = 0·68) followed by non-availability of pedestrian facilities, and obstacles or discontinuity in the pedestrian facilities (PWI = 0·62). Vehicular movement on the roads where proper pedestrian facilities are not available is also a cause of concern

Table 1. Perception index of the factors influencing usability of public parks

Factors influencing usability of public parks	PWI = $(\sum P_i \times N_i)/\sum N_i$
Walking to public parks	0·99
Use vehicle to access	0·01
Walk distance importance	0·69
Walk distance satisfaction	0·26
Quality of parks (prefer private parks)	0·34
Road safety	0·58
Crime or fear of crime	0·67
Period of the day (morning)	0·20
Period of the day (mid-day)	0·05
Period of the day (evening/afternoon)	0·75
Illumination in the parks in the evening	0·68
Pavement condition of roads and pedestrian facilities	0·43
Non-availability of pedestrian facilities, obstacles or discontinuity in pedestrian facilities	0·62
Maintenance of parks	0·47
Entry fees	0·01

Source: household and public park use survey, 2014

Table 2. Correlation coefficients between public parks users and accessibility variables and VIF test results

Parameter	Correlation coefficients					VIFs				
	Average number users	Pedestrian pavement to road network ratio	Number of access streets into park	Area of park: m^2	Illumination level: lux	Average number users	Pavement to road network ratio	Number of access streets into park	Area of park: m^2	Illumination of parks in evenings measured in lumens: lux
Average number of users	1·0	0·82	0·69	0·70	0·84	−9·69	4·31	3·04	2·50	3·94
Pedestrian pavement to road network ratio	0·82	1·0	0·32	0·42	0·41	4·31	−0·56	−1·57	−1·50	−2·04
Number of access streets to parks	0·69	0·32	1·0	0·23	0·43	3·04	−1·57	0·31	−0·78	−1·69
Area of park	0·70	0·42	0·23	1·0	0·45	2·50	−1·50	−0·78	0·72	−1·48
Illumination level: lux	0·84	0·41	0·43	0·45	1·0	3·94	−2·04	−1·69	−1·48	−0·08

(PWI = 0·58). However, the pavement condition of roads and pedestrian facilities (PWI = 0·43) and the maintained condition of public parks (PWI = 0·47) do not significantly influence the use of parks. Vehicular use has the least influence (PWI = 0·01).

Lack of safety due to crime or fear of crime (PWI = 0·67) is also one of the major reasons for the lower use of public parks. Although it is necessary to note the importance of crime and safety for park use, this investigation only focused on the aspects of accessibility to public parks. Hence, crime and safety aspects that warrant a separate investigation were excluded from the scope of this investigation.

Table 2 presents the correlation coefficients of various accessibility factors with the number of park users and VIF test results. The correlation coefficient suggests that a higher level of illumination in the public parks (correlation coefficient (c.c = 0·84)) and pedestrian facility network to road network ratio (c.c = 0·82) significantly influence the use of public parks. Variables such as the number of access streets into parks (c.c = 0·69) and the area (size) of parks (c.c = 0·70) are also found to be fairly correlated with the use of parks. However, a lower correlation between park uses and variables such as average pedestrian facility widths (c.c = 0·47), parking facilities (c.c = 0·34) and longest sight distance towards public parks (c.c = 0·51) was observed. Furthermore, VIF test results have shown that pedestrian facility network to road network ratio, the number of access streets into the parks, the area (size) of the park (m^2) and illumination of the parks in the evenings are fairly independent and mutually exclusive of one another (VIF < 4).

Table 3 provides the regression variables and significant test results between the number of park users and various major accessibility variables obtained from multiple regression and analysis of variance analysis. The high r^2 values (ranging between 0·79 and 0·92) of the relation between the independent accessibility variables and number of park users imply that strong associations exist between the four accessibility variables (namely, pedestrian facility network to road network ratio, number of access streets to parks, area (size) of parks and illumination level of parks in the evenings) and park uses. Similarly, the significance test establishes that significant relationships exist between the above-mentioned four accessibility variables with the park uses in Bloemfontein (p values – both one tailed and two tailed – are <0·05 for $\alpha < 0·05$). Thus, pedestrian facility network to road network ratio, illumination of parks in the evenings, number of access streets to parks and the area (size) of the parks (m^2) are considered the major accessibility variables which significantly influence the use of public parks in Bloemfontein.

Table 3. Regression variables and significance test results

Parameter	r^2	*T* value	df	*p**	*p***
Pedestrian facility network to road network ratio	0·92	7·40	32	0·00000001	0·00000002
Number of access streets	0·79	7·34	32	0·00000001	0·00000002
Area of parks	0·88	2·82	40	0·00388	0·00776
Illumination level of parks in the evening	0·92	6·82	40	0·0000003	0·0000006

*Single tailed; **two tailed *p* values for $\alpha < 0{\cdot}05$

5.2 Influence of major influential accessibility factors on users of public parks

5.2.1 Influence of pedestrian facility network to road network ratio on the number of users of public parks in the study area

Figure 1(a) and Equation 2 show the relation between the pedestrian pavement network to road network ratio and the average number monthly users of the public parks in the study area

2. $$Y_1 = 2{\cdot}032e^{5{\cdot}9542X_1}$$

$$r^2 = 0{\cdot}92$$

Y_1 is the number of public park users per month and X_1 is the pavement network to road network ratio.

Figure 1(a) shows that the average number of monthly users increases gradually (non-linearly) as the pedestrian facility to road network ratio increases up to 0·85; however, it increases exponentially as the ratio improves beyond 0·85. This indicates that unavailability of pedestrian facilities commensurate to the road network can be a barrier for use of the parks. However, a more complete pedestrian facility (i.e. pedestrian facilities without many obstructions provided along almost all roads leading to the parks) will enhance the use of parks.

5.2.2 Influence of the number of access streets leading into the public parks in the study area

Figure 1(b) and Equation 3 show the relation between the number of access streets leading to the public parks and the average number monthly users of the public parks in the study area

3. $$Y_1 = 52{\cdot}423X_2 + 28{\cdot}866$$

$$r^2 = 0{\cdot}79$$

Y_1 is the number of public park users per month and X_2 is the number of access streets.

The relation posits that increase in the number of access streets leading towards public parks increases the number of park users linearly. The maximum number of users is observed in the parks where the number of access streets is exceedingly high (ten), and a very low number of park users are found where the number of access streets is very low (two). However, such scenarios are exceptional. The availability of three to five access streets leading to parks is found to bring about a reasonably good number of users. Therefore, an adequate number of access streets are necessary to improve the use of parks in the study area. Although, it may not be possible to increase the number of access streets to existing parks due to physical-, land- and infrastructural-constraints, such consideration will be useful when developing new public parks.

5.2.3 Influence of the area (size) of the public park in the study area

Figure 1(c) and Equation 4 present the relation between the area (size) of the public parks and the average number users of the public parks in the study area

4. $$Y_1 = -6 \times 10^{-9}X_3^2 + 0{\cdot}0039X_3 + 193{\cdot}1$$

$$r^2 = 0{\cdot}88$$

Y_1 is the number of public park users per month and X_3 is the area of parks in square metres.

Figure 1(c) suggests that exceptionally large parks attract the maximum number of users, but such parks are exceptions in residential areas. The trend analysis shows that there is no significant variation in park use for park sizes up to an area of about 12 000 m^2. However, the number of users increases non-linearly (with polynomial relationship) to a significant level as the size of parks increases appreciably. Since, the majority of parks in residential areas have a limited size, an increase in the area of public parks to a limited extent may not necessarily

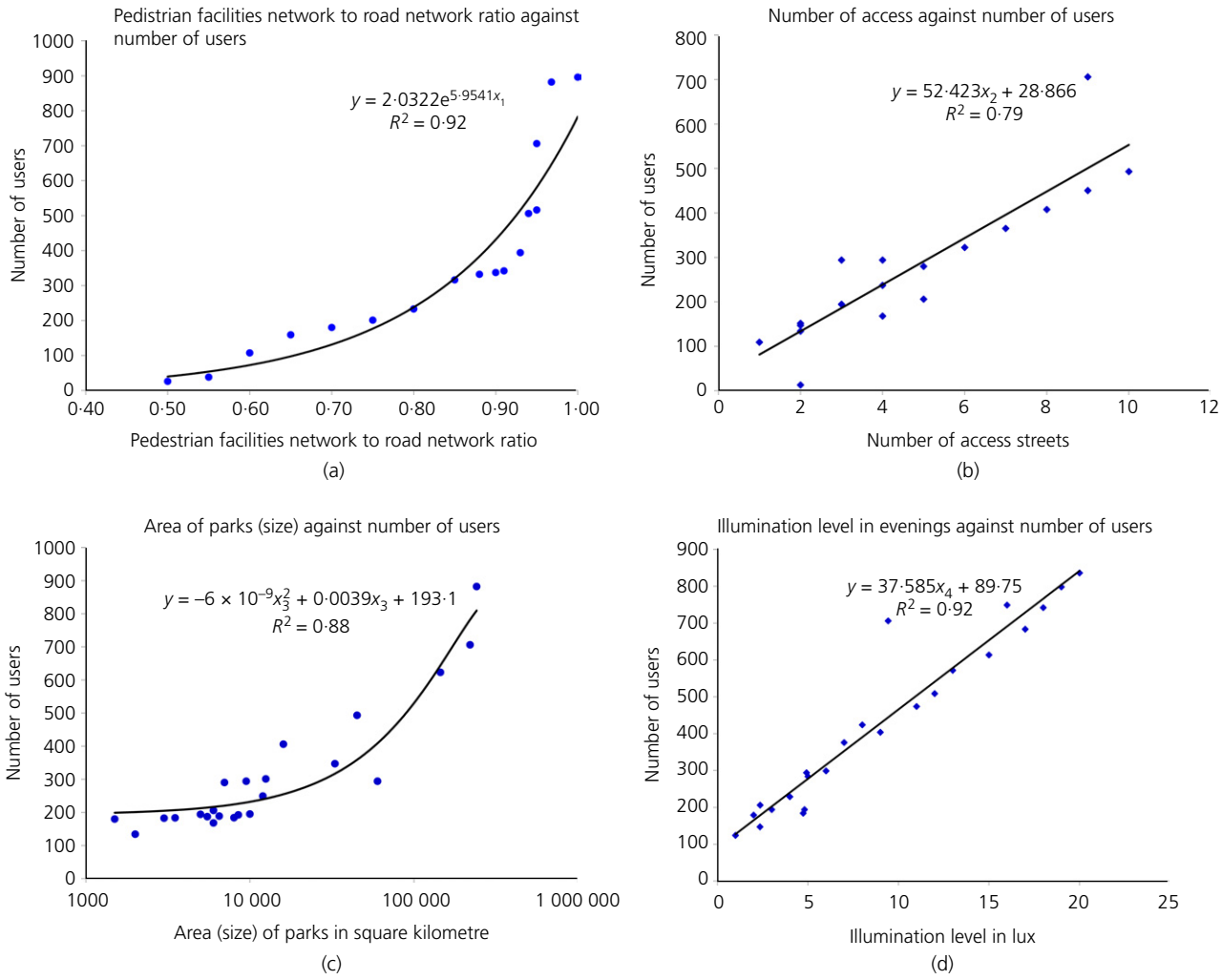

Figure 1. (a) Influence of pedestrian facilities network to road network ratio on the number of users of public parks, (b) influence of the number of access streets leading to the public parks on the number of users of public parks, (c) influence of the area (size) of the public park on the number of users of public parks, (d) influence of the level of illumination in public parks in the evenings on the number of users of public parks

increase the number of park users significantly. Concurrently, its impact on the use of parks cannot be undermined and the size of parks may necessarily be considered as an important variable when developing new parks.

5.2.4 Influence of the level of illumination in public parks in the evenings on the number of users of public parks in the study area

Figure 1(d) presents the relation between the illumination levels in the evenings and the average number of monthly users of the public parks in the study area. The relationship is presented in the following equation

$$5. \quad Y_1 = 37{\cdot}585X_4 + 89{\cdot}75$$

$$r^2 = 0{\cdot}92$$

A linear relationship exists between illumination level and the number of park uses. Parks with very low illumination (<3 lux) experience very few visitors, whereas a high illumination level (>10 lux) encourages more people to use the parks. This trend analysis informs that the use of parks is enhanced significantly by the increase in the level of illumination in the public parks in the evenings. Thus, as the majority of the parks in the study area have an illumination level <20 lux as recommended by the Encyclopaedia of Occupational Health and Safety, significant improvement in the illumination in the public parks during evening hours is essential to improve the uses of public parks.

6. Conclusion

The study explored the major accessibility parameters that largely influence the uses of public parks and examined their level of influence. For this purpose, a case study was conducted by considering Bloemfontein city of South Africa. A survey research method that includes household survey, physical survey and public parks use survey was used. Relevant statistical analyses including regression and trend analyses were adopted to conduct the investigation. The relationship and causation between the number of park users and accessibility variables were established by the concurrent analyses of the perception index, correlation coefficients, VIF test, significance tests and regression and trend analyses. The investigation showed that the pedestrian facility network to road network ratio, number of access streets to public parks, size of parks and illumination level of public parks are the major accessibility parameters which influence the uses of public parks in the study area. However, it is apparent that out of the four major variables, pedestrian facility network to road network ratio, number of access streets to public parks and illumination level of public parks are of higher significance and could be crucial to increase the use of parks in comparison to the size of parks, which has relatively less influence. Walking to parks and walking distance also influence the park users to visit the parks; thus, the provision of continuous pedestrian facilities will encourage walking and are also likely to improve pedestrian park user safety. On the other hand, other accessibility parameters such as average pavement widths, longest sight distance towards public parks and availability of parking lots have insignificant influence on the park users to visit public parks.

The conclusion, however, is partial because the aspect of crime and safety, which is likely a consideration, was not assessed due to lack of available data. Therefore, a key recommendation is to evaluate this aspect further. The other limitation of the study is that the scope of the research was confined to the investigation of accessibility-related parameters on the public park uses in Bloemfontein. As a result, explicit analyses regarding the influence of socio-cultural-, environmental-, demographic- and behavioural-related parameters were kept out of the scope of the investigation. Further research is required to extend the study to these aspects. Besides, studies also need to be conducted by considering other cities of the country in order to generalise the research implications. However, the current research shows that road network and pavement network ratio, number of access streets to public parks, illumination level of public parks and size of parks are the four important accessibility parameters, which need to be considered carefully when developing policy interventions for the improvement of use of public parks in the residential areas of Bloemfontein city, South Africa.

The practical relevance of the findings of the investigation pertains to the identification of major accessibility variables and their relative influence on the use of public parks in the residential areas of South African cities under different scenarios. On the basis of influences of these factors, policy interventions and appropriate provision of accessibility infrastructure and services can be made to improve the use of public parks in the residential areas of South African cities.

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